

# Making a power supply that produces 1000 A with ripple of 50 parts per million – CCI Summer 2020

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## Background and Project Mission

- Project’s mission is to show what type of power supply is best used to produce 1000 A with ripple of 50 ppm
- Current ripple is the amount of change in the current over time when it should be stable
- This is necessary to create a stable magnetic field so that target particle in beam stays in the correct position
- Six simulations of power supplies were done at LTSpice: Two and three phase bridge power supplies with various filters

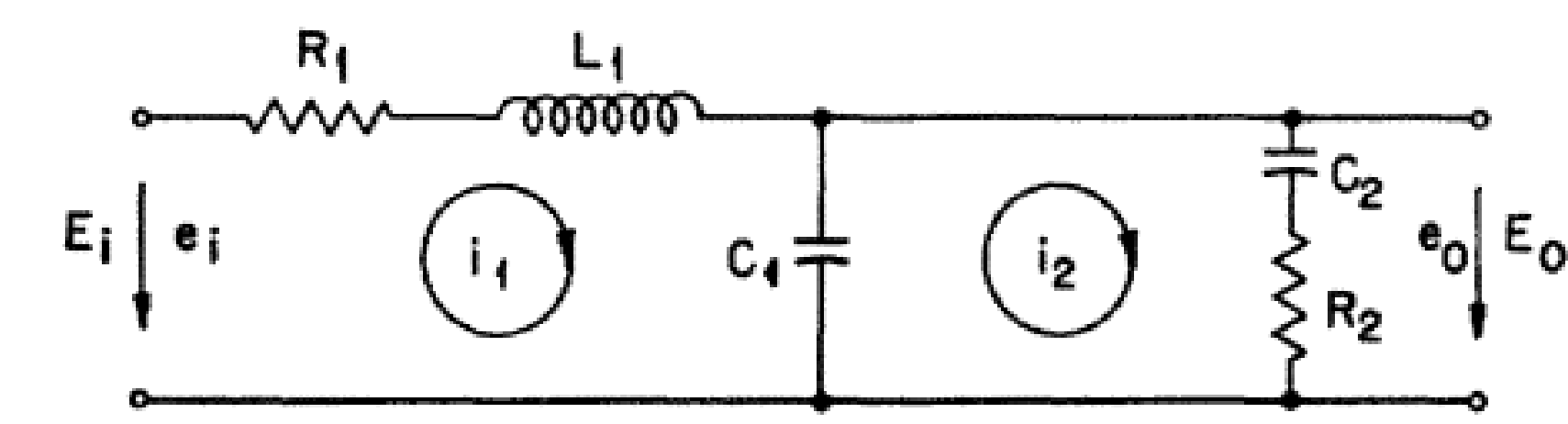
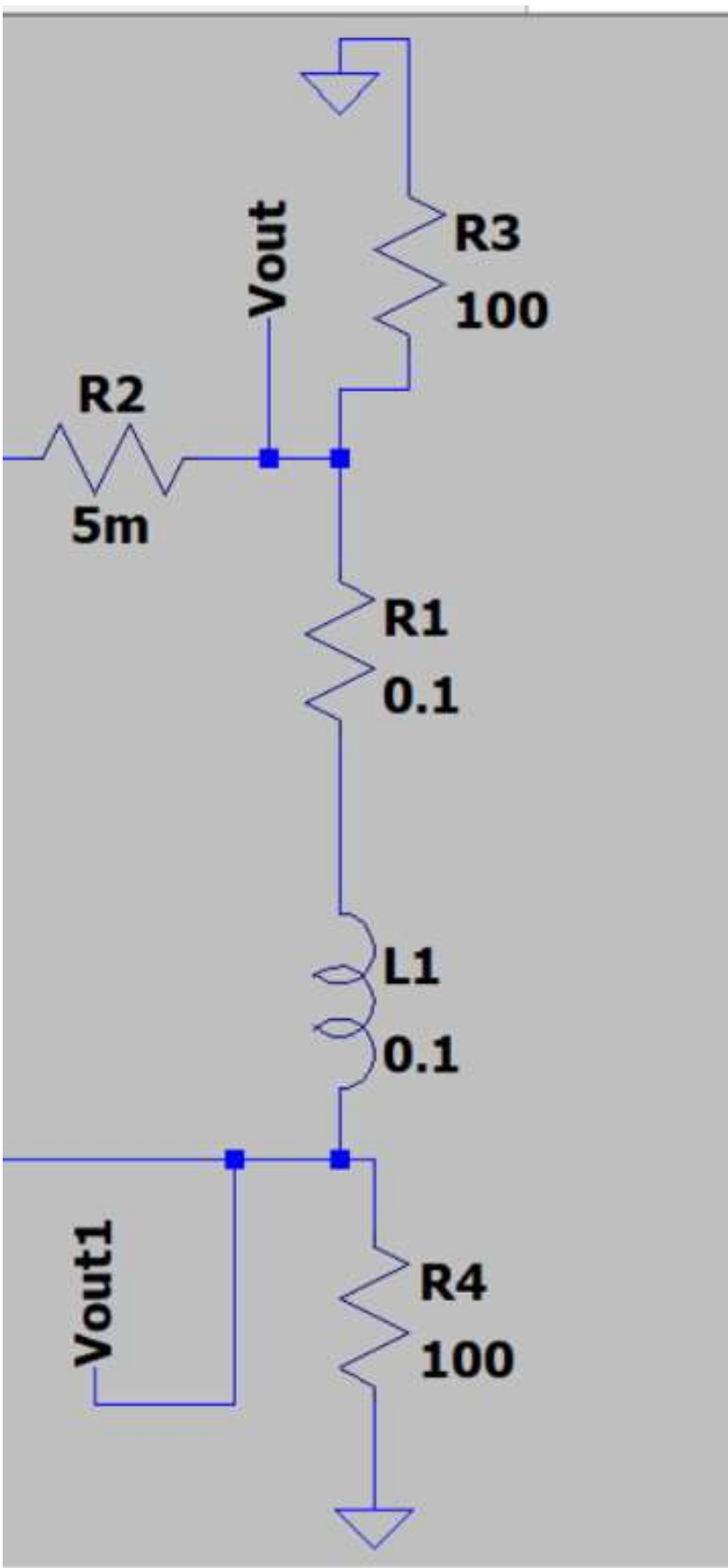


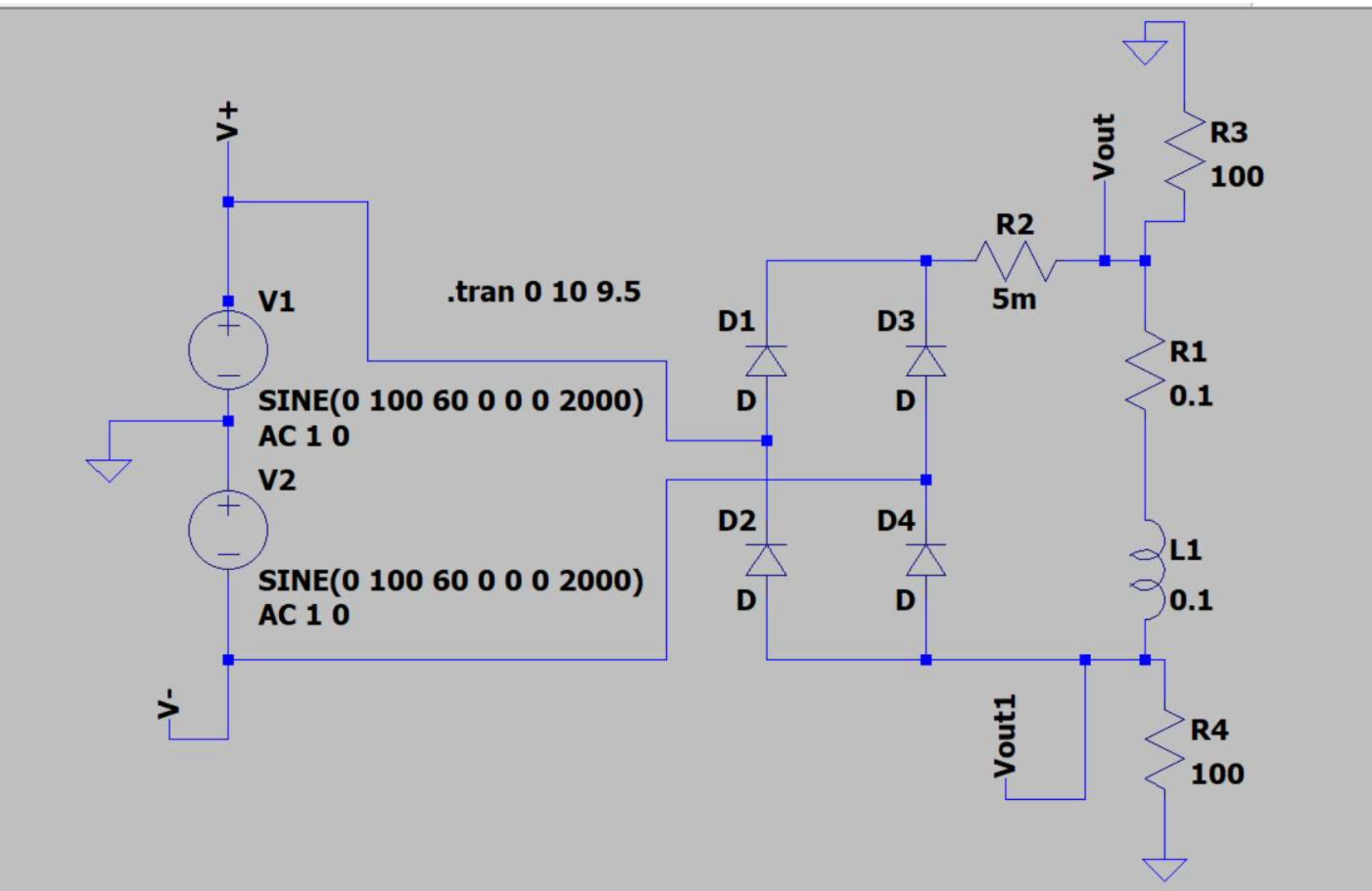
Fig. 3. Improved LCR low-pass filter.

## General Description of Magnet Load



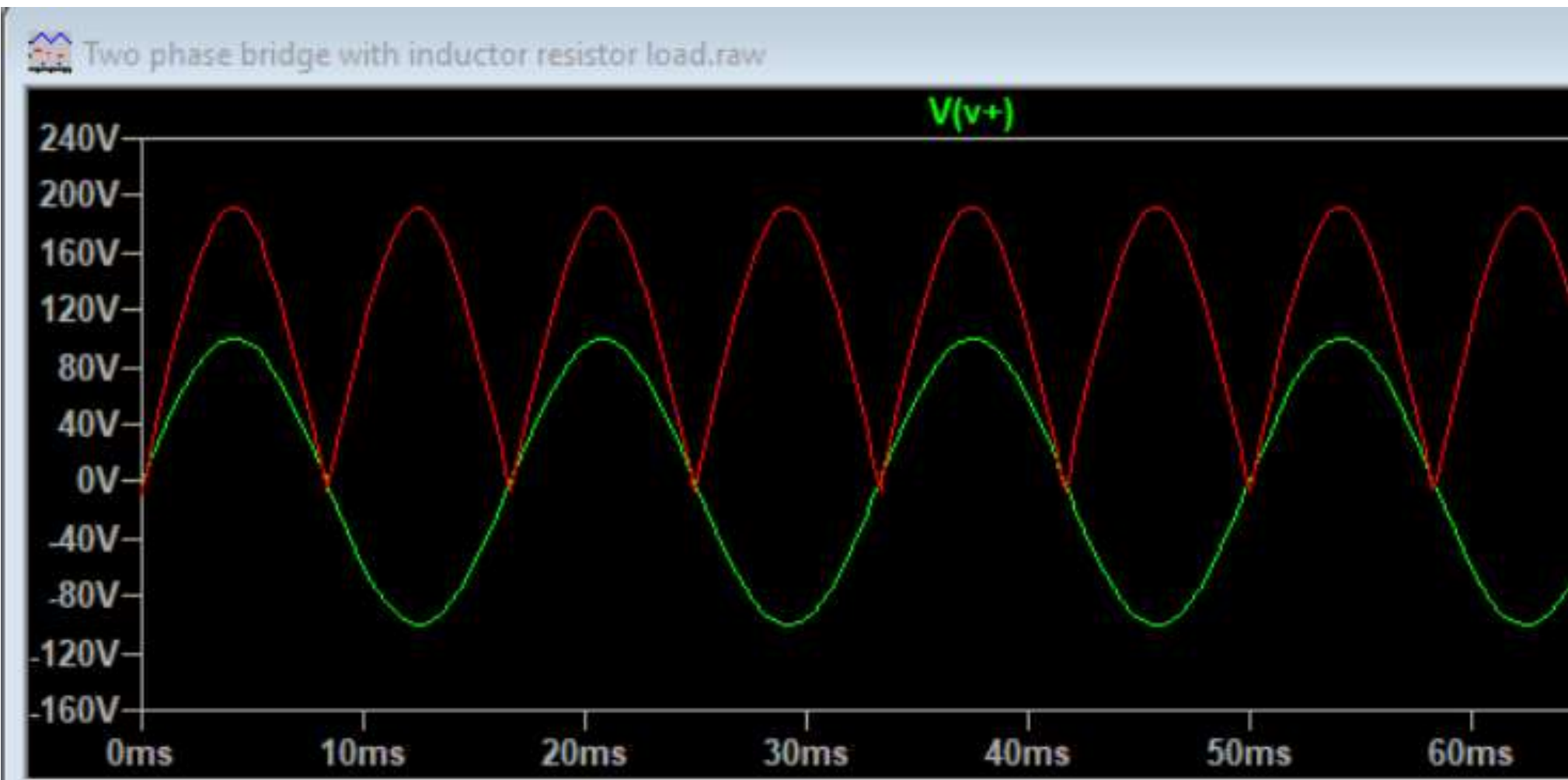
- In the picture:
- R1 and L1 represent a magnet load
- R2 represents basic resistance of wiring
- R4 and R3 are balancing resistors so that voltage on the magnet is balanced about ground.
- Vout and Vout1 were created to measure difference in voltage

## Two Phase Bridge Power Supplies with Load only (Resistor and Inductor)

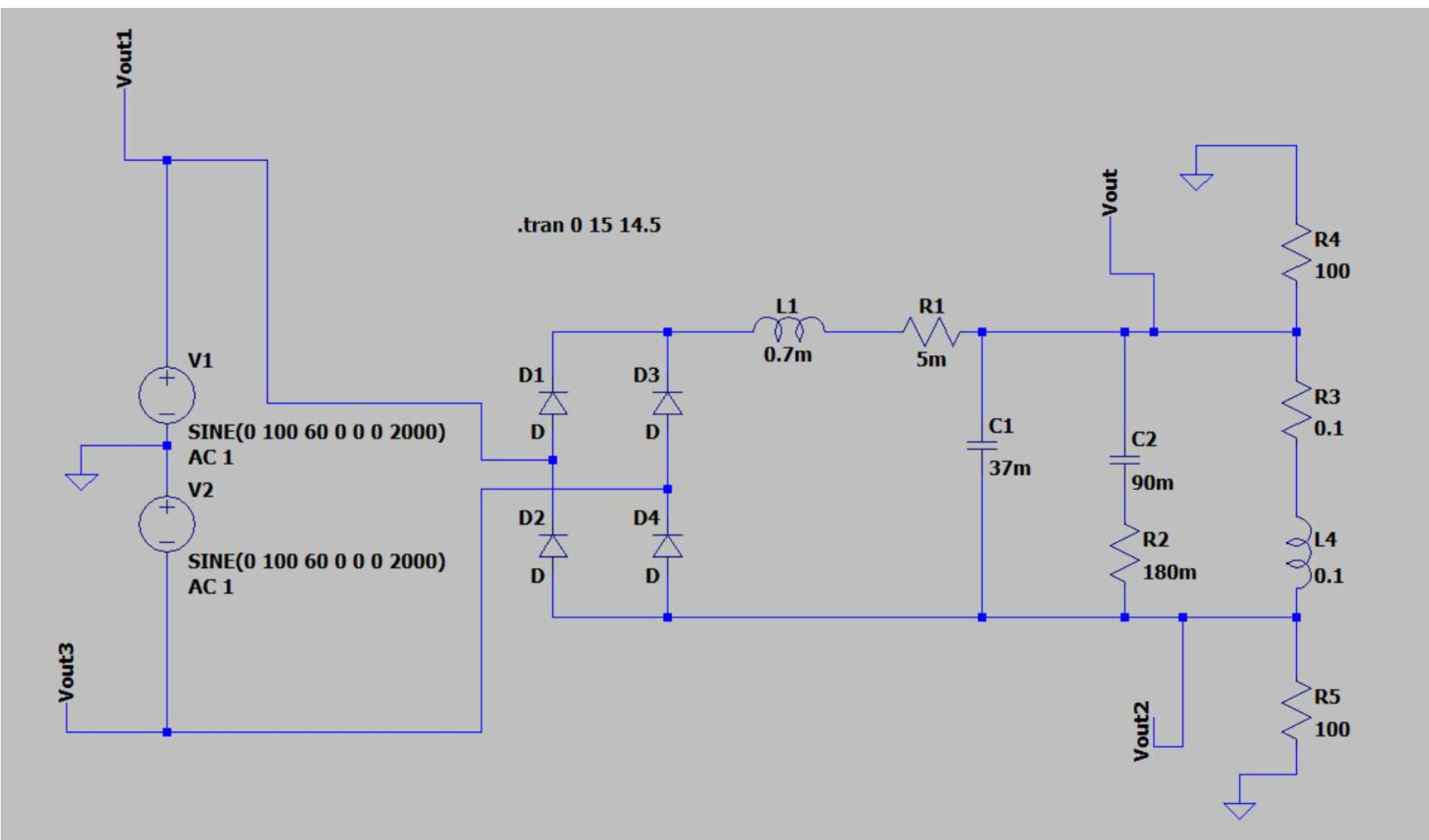


## Simulated Voltages for Two Phase

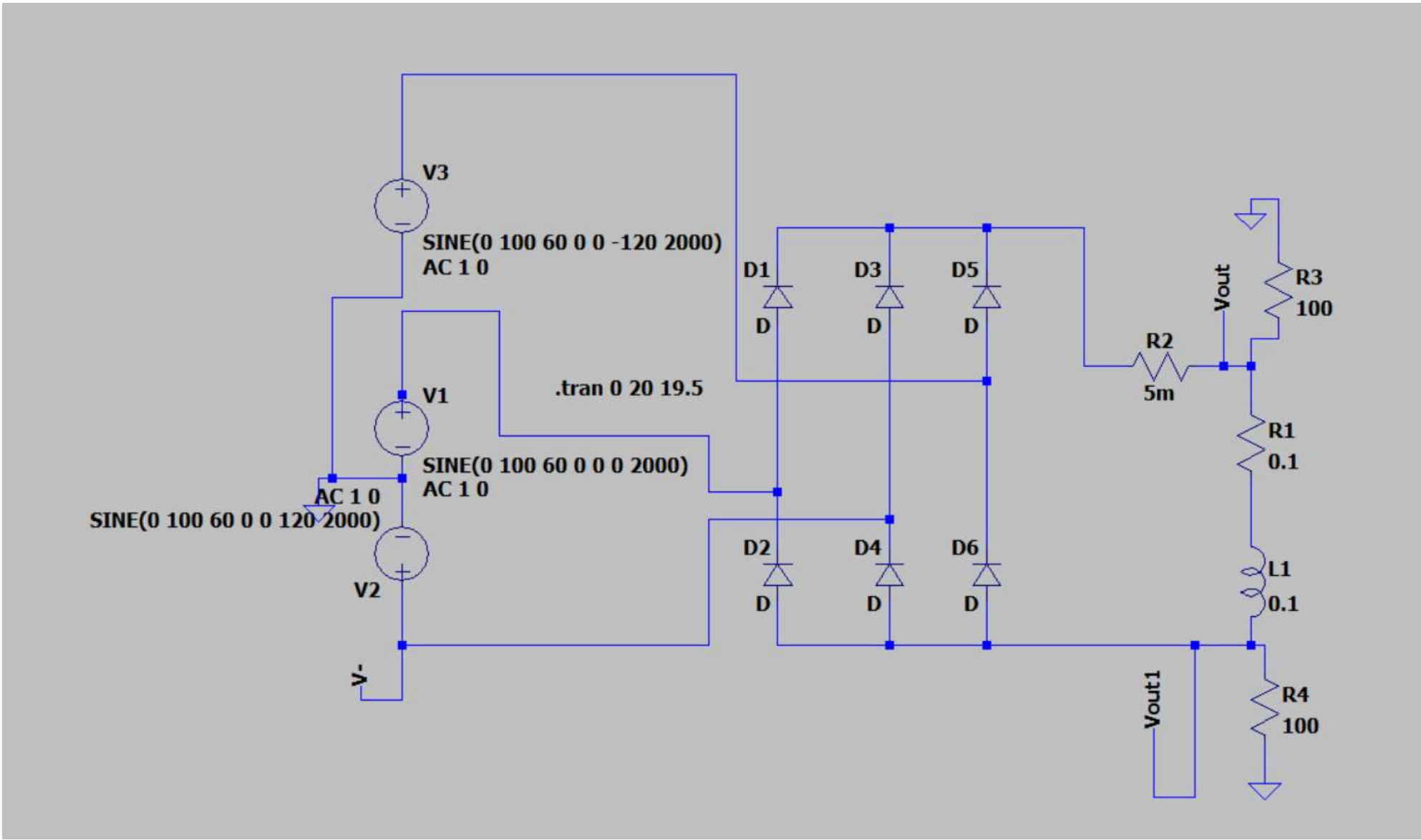
- Red line represents output voltage  $V(out) - V(out1)$
- Green line represents input voltage  $V(V+)$



## Two Phase Bridge Power Supply with Praeg Filter

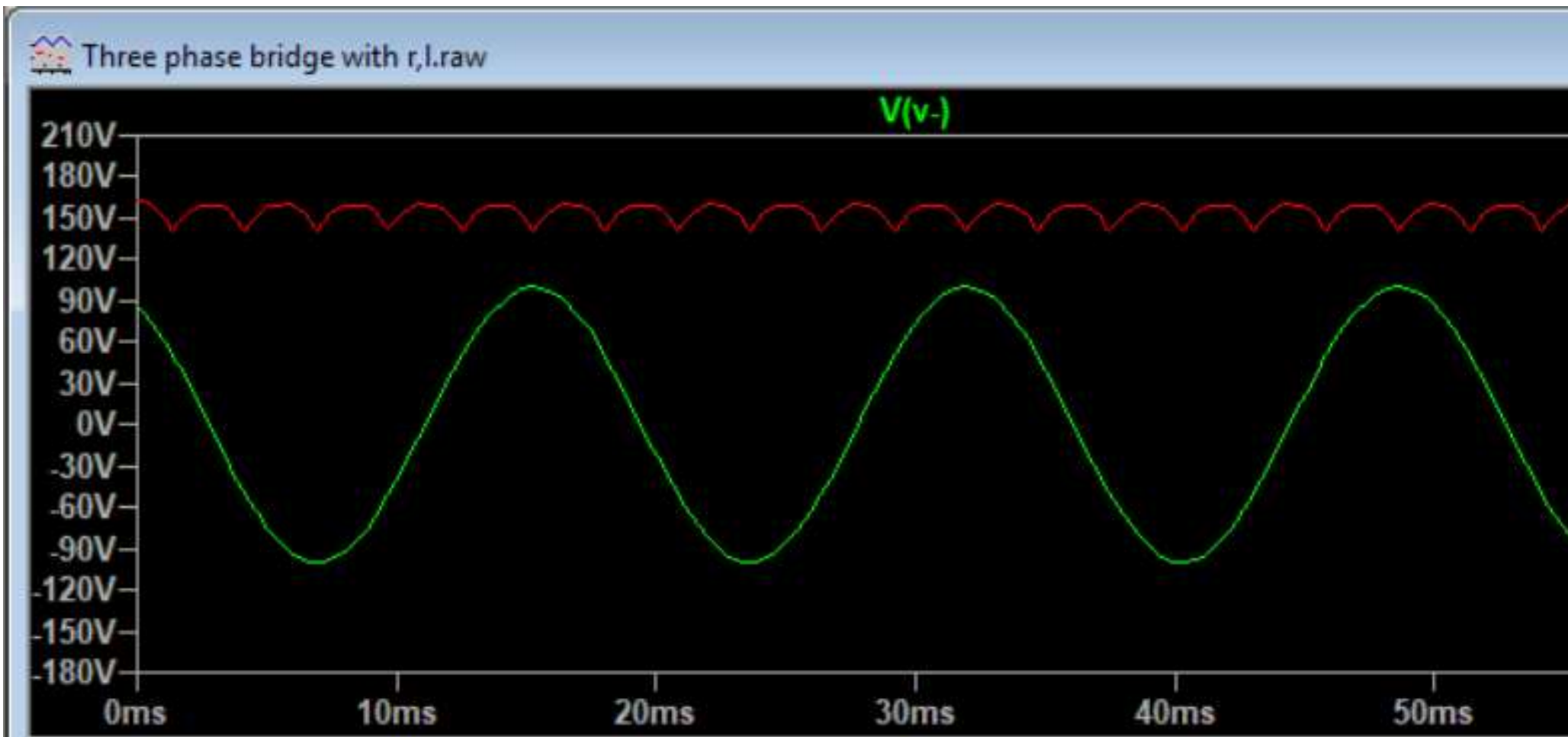


## Three Phase Bridge Power Supply with Load only (Resistor and Inductor)

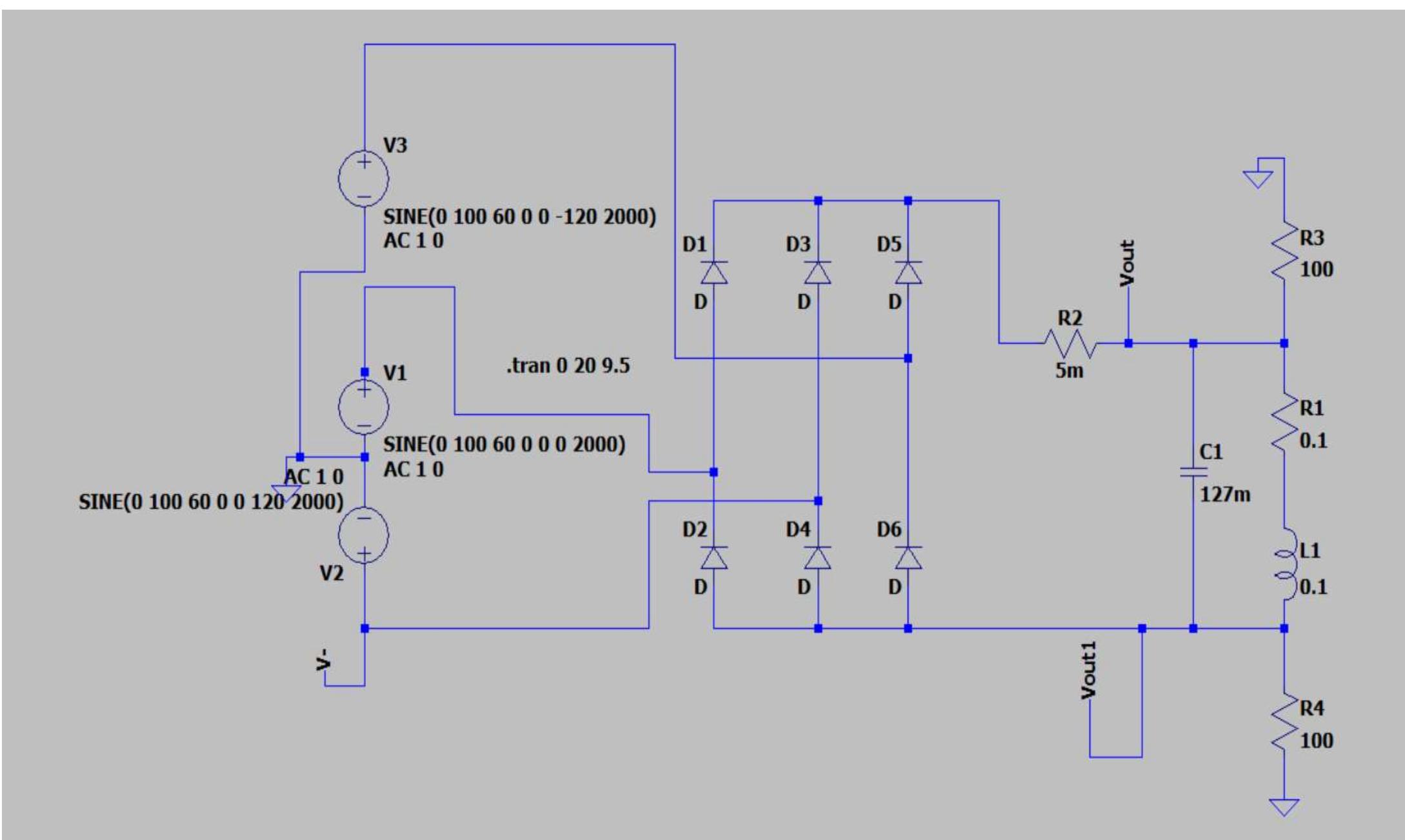


## Simulated Voltages for Three Phase

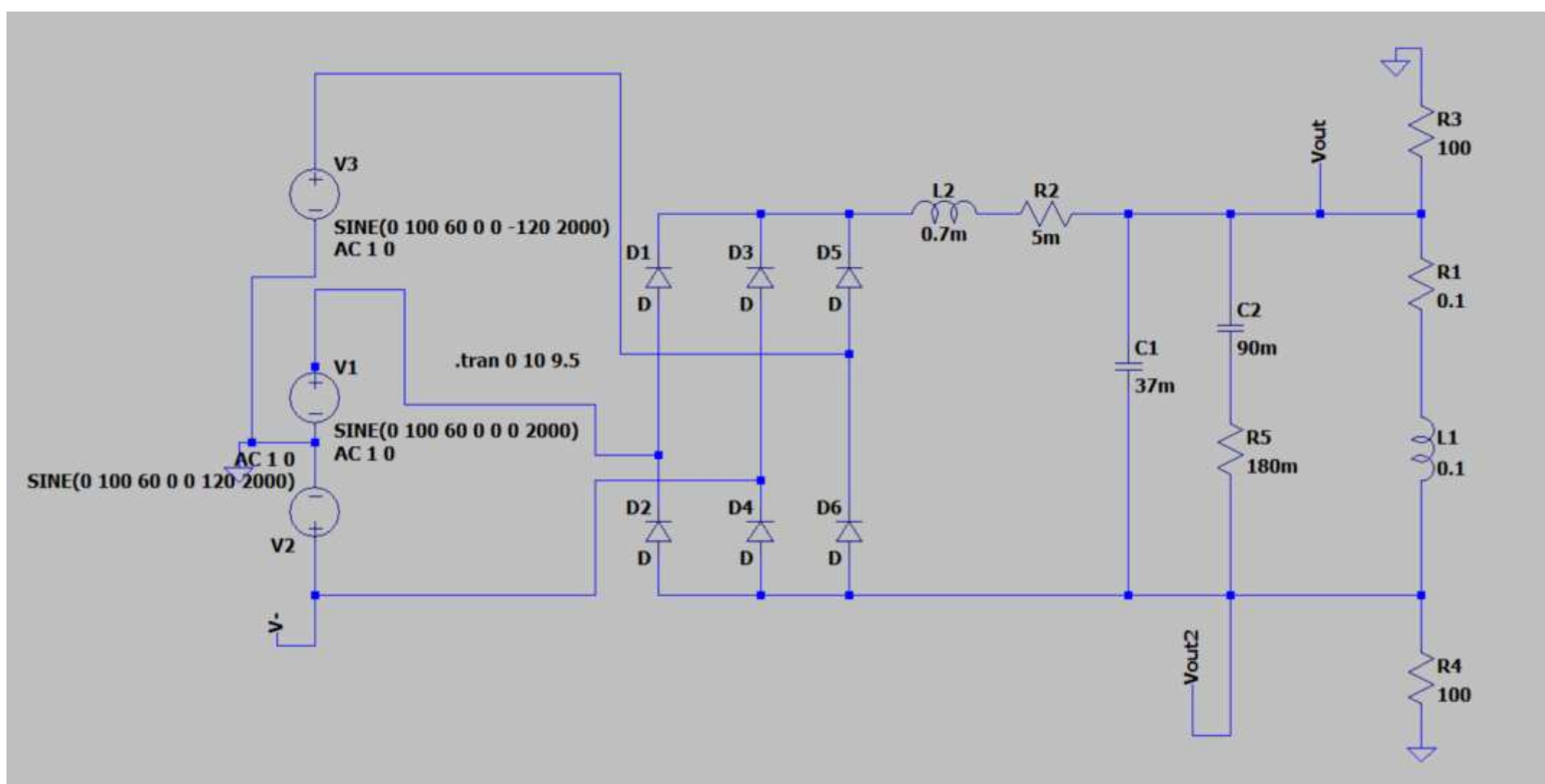
- Red line represents output voltage  $V(out) - V(out1)$
- Green line represents input voltage  $V(V+)$



## Three Phase Bridge Power Supply with Resistor, Capacitor, and Inductor



## Three Phase Bridge Power Supply with Praeg Filter



## Measurements

	2 phase bridge with load only (R & L)	2 phase Bridge with R, C and L C = 127mF	2 phase bridge with R,L and C = 685mF	2 phase Bridge with Praeg filter C = 127mF
Current Percentage Ripple	0.16 %	0.041 %	0.007%	0.011 %
Peak to Peak current	1.94 A	641.47 mA	123.751 mA	123.24 mA
Average Current	1.170 kA	1.55 kA	1.638 kA	1.1602 kA
Voltage Ripple [V(out) - V(vout1)]	197.5 V	56 V	11 V	11 V
Avg Volt [V(out) - V(vout1)]	116.33 V	156.67 V	165.35 V	117.19

	3 phase bridge with R & L	3 phase bridge with R,L & C C = 127mF	3 phase bridge with praeg filter
Current Percentage Ripple	0.0044%	0.0021%	0.000037%
Peak to Peak current	67.60 mA	32.48 mA	566 uA
Average Current	1.5361 kA	1.542 kA	1.5217 kA
Voltage Ripple [V(out) - V(vout1)]	19.3 V	8.8 V	95 mV
Avg Volt [V(out) - V(vout1)]	154.16	155.16	153.7

## Conclusion

- As shown, 3 phase bridge power supplies achieve the goal of reducing the current ripple below 50 parts per million.
- For this reason, these types of power supplies are used at Fermilab